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Beverage Choices Affect Adequacy of Children's Nutrient Intakes

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Objective: To assess the relationship between beverage choices and the adequacy of nutrient intakes among children and adolescents.

Design: Beverages reported in 24-hour recall records were classified as milk, 100% juice, fruit-flavored drinks, or carbonated sodas. Recommended intakes were based on Recommended Dietary Allowances or Dietary Reference Intakes.

Participants: Four thousand seventy children aged 2 to 5, 6 to 11, and 12 to 17 years participating in the 1994-96 Continuing Survey of Food Intakes by Individuals.

Statistical Analysis: The likelihood of achieving recommended intakes of selected nutrients on the day of recall was assessed with multiple logistic regression including ounces of milk, juice, fruit-flavored drinks, and carbonated sodas in the model while controlling for sex, age in years, race/ethnic group, household income, and total energy intake.

Results: Milk consumption was positively ($P<.0001$) associated with the likelihood of achieving recommended vitamin A, folate, vitamin B_{12}, calcium, and magnesium intakes in all age strata. Juice consumption was positively ($P\leq.001$) associated with achieving recommended vitamin C and folate intakes in all age strata and magnesium intakes among children aged 6 years and older. Carbonated soda consumption was negatively ($P\leq.01$) associated with achieving vitamin A intake in all age strata, calcium in children younger than 12 years, and magnesium in children aged 6 years and older.

Conclusion: Beverage choice can have a significant effect on the nutrient adequacy of the diets of children and adolescents.

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MILK consumption among children and adolescents in the United States decreased 25% to 30% and the consumption of citrus juice declined slightly between 1977-78 and 1994-95,[1] while carbonated soda consumption increased 41% between 1989-91 and 1994-95.[2] Investigators have asserted that the displacement of milk and juice with carbonated sodas in children's diets has a negative effect on nutritional quality.[3,4] Milk and juice are among the top sources of vitamin A, vitamin C, B vitamins, vitamin D, calcium, magnesium, and phosphorus for children in the United States.[5,6] The Interagency Board for Nutrition Monitoring in the United States has identified calcium as a nutrient of current public health concern, and vitamin A, vitamin C, folate, vitamin B_{12}, and magnesium as nutrients of potential public health concern.[7] We investigated interrelationships among consumption of milk, juice, fruit-flavored drinks, and carbonated sodas and their association with the intakes of these 6 nutrients among children aged 2 to 17 years in the 1994-96 Continuing Survey of Food Intakes by Individuals (CSFII).[8]

RESULTS

BEVERAGE CONSUMPTION

The proportion of children drinking milk on the day of recall was significantly higher among participants aged 2 to 5 years and those aged 6 to 11 years than among 12 to 17 year-olds (**Table 1**). Among those aged 12 to 17 years, the proportion drinking milk was significantly higher among boys than among girls. Half of the participants aged 2 to 5 years drank juice on the day of recall but only about one third of children aged 6 years and older drank juice. The proportion of children drinking fruit-flavored drinks was higher among

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METHODS

PARTICIPANTS AND DATA COLLECTION

The Continuing Survey of Food Intakes by Individuals is a nationally representative survey of the noninstitutionalized civilian population of the United States. Detailed descriptions of the sample and interview procedures are available.[8] Diet recall interviews were scheduled approximately equally on each day of the week and in each month of the year. A parent or other adult responded for children younger than 6 years; children between the ages of 6 and 11 years responded with help from an adult; and children aged 12 years and older responded independently. We excluded children with incomplete data (12.7%) and those who were ill on the day recalled (4.0%). This analysis is based on 1800 children aged 2 to 5 years, 1282 children aged 6 to 11 years, and 988 children aged 12 to 17 years who provided a recall for day 1 of the survey. We do not have data on nutrients derived from vitamin and mineral supplements. The data set only indicates whether children took supplements but does not include information on the nutrient content of the supplements.

BEVERAGE CLASSIFICATION

All beverages reported in the 24-hour recall were classified as milk, 100% fruit or vegetable juice, fruit-flavored drinks including those that contain part juice or added vitamins (almost exclusively vitamin C at the time of the survey), carbonated sodas, sports drinks, coffee and tea, or alcoholic beverages. Only 7.3% of the servings of carbonated sodas were described as diet or calorie-free so we did not distinguish between regular and diet sodas. The energy content of regular carbonated sodas, 100% juice, and 1% fat milk are similar, about 100 to 110 kcal per 8 oz. Water consumed as a beverage was not recorded in the dietary recalls.

DEFINITION OF RECOMMENDED INTAKES

We used the most current authoritative standard available for each nutrient. Recommended intakes were defined as the Recommended Dietary Allowance for vitamin A and vitamin C,[9] the Estimated Average Requirement for folate, vitamin B$_{12}$, and magnesium, and the Adequate Intake for calcium.[10,11] This results in a mixed set of criteria but is consistent with the recommendations of the Institute of Medicine's Food and Nutrition Board for dietary evaluation during the transition to the new Dietary Reference Intakes.[10,11]

STATISTICAL METHODS

We used the 24-hour recall records from day 1 of the CSFII survey. Most children provided 2 days of recall, but our question, whether beverage choice on a given day affects the likelihood of achieving recommended nutrient intakes on that day, was appropriately addressed using a single day. Using both days could introduce a bias in the analysis because while 2 days of recall from a given participant were not independent, the nature of the correlation between days could not be assumed to be the same for all participants.

We tabulated the consumption of beverages and examined associations among types of beverages by rank order correlations. We used multiple logistic regression to calculate the association between beverage consumption and the likelihood of achieving recommended intakes of nutrients on the day of recall while controlling for total nutrient intake, sex, age in years within age stratum, race/ethnic group (non-Hispanic white, non-Hispanic black, Mexican American), and household income expressed as the poverty income ratio (PIR). The PIR adjusts household income for household size and the cost of living at the time of the survey.[6] To determine whether our analysis was unduly influenced by the few children who reported very high consumption of various beverages, we ran the multiple logistic regression analyses including and excluding children at or beyond the 99th percentile of consumption of any beverage for age stratum and sex. The adjusted odds ratios (OR) from the models excluding outliers did not differ significantly from those including all children.[12] Only models based on the whole sample are presented. Because we performed multiple tests, we set the criterion for statistical significance at $P<.01$.[13] Analyses were performed in SUDAAN (Research Triangle Institute, Research Triangle Park, NC), taking into account the sample weights and the stratified, multistage probability structure of the sample.[14]

children aged 11 years and younger than among those aged 12 to 17 years. Seventy percent of the fruit-flavored drinks named contained either part juice or added vitamins (data not shown). Carbonated soda consumption increased significantly across age strata. Sports drinks were reported by 5% or fewer of children in any age stratum. Few children younger than 12 years but one fifth of teenagers drank coffee or tea. Only 2 boys and 3 girls aged 12 to 17 years reported consuming alcoholic beverages.

Some children did not report consuming any of a given beverage on the day of recall and some reported consuming large volumes of some beverages (**Table 2**). To provide a reasonable estimate of portion size distribution the range presented in Table 2 includes the nonconsumers of each beverage, but the median consumption values include only those children who reported consuming the beverage. The maximum reported values are not implausible but they do confirm that some children drank substantial amounts of certain beverages, most strikingly fruit-flavored drinks and carbonated sodas among boys aged 12 to 17 years.

Carbonated soda consumption was significantly negatively correlated with both milk and juice consumption in all age strata (**Table 3**). Fruit-flavored drink consumption was significantly negatively correlated with milk consumption among 6- to 11-year-olds and with 100% juice consumption among 2- to 5-year-olds. These correlations were modest, accounting for only 10% to 15% of the variance in consumption of milk and juice. There were no significant correlations between milk and juice consumption in any age stratum. There were no significant correlations between either coffee and tea consumption or alcoholic beverage consumption and milk, juice, or carbonated soda consumption (data not shown).

Table 1. Beverage Consumption Among Children Aged 2-17 Years*

Age Group, y	Milk†	100% Juice‡	Fruit-Flavored Drinks§	Carbonated Soft Drinks‖	Sports Drinks	Coffee or Tea¶	Alcoholic Beverages
2-5							
Boys (n = 893)	75	53	39	35	1	9	0
Girls (n = 907)	75	52	36	33	2	8	0
6-11							
Boys (n = 643)	76	35	36	47	2	11	0
Girls (n = 639)	72	40	35	45	1	12	0
12-17							
Boys (n = 511)	63	34	25	68	5	21	0.2
Girls (n = 477)	49	33	27	63	2	22	0.5

*Data are given as percentage of children consuming each beverage on the day of recall.
†Age group difference between 12- to 17-year-olds and other age strata, P≤.0001; sex difference among the 12- to 17-year-olds, P≤.0001.
‡Age group difference between 2- to 5-year-olds and other age strata, P≤.0001.
§Age group difference between 12- to 17-year-olds and other age strata, P≤.0001.
‖All age strata significantly different, P≤.001.
¶Age group difference between 12- to 17-year-olds and other age strata, P≤.0001.

Table 2. Amount of Beverages Consumed by Children Aged 2-17 Years

Age Group, y	Intake, Range (Reported by All Children), Median (Reported by Consumers), oz						
	Milk	100% Juice	Fruit-Flavored Drinks	Carbonated Soft Drinks	Sports Drinks	Coffee or Tea	Alcoholic Beverages
2-5							
Boys (n = 893)	0-71, 12	0-89, 7	0-61, 8	0-65, 8	0-55, 6	0-46, 7	...*
Girls (n = 907)	0-63, 11	0-48, 7	0-65, 8	0-65, 8	0-23, 6	0-46, 7	...
6-11							
Boys (n = 643)	0-109, 12	0-57, 7	0-69, 9	0-85, 13	0-31, 7	0-67, 8	...
Girls (n = 639)	0-44, 11	0-44, 7	0-65, 8	0-93, 12	0-20, 8	0-46, 8	...
12-17							
Boys (n = 511)	0-71, 15	0-58, 9	0-130, 16	0-210, 24	0-62, 19	0-106, 13	0-23, 18†
Girls (n = 477)	0-91, 8	0-49, 8	0-71, 9	0-112, 16	0-34, 16	0-46, 12	0-23, 11‡

*Ellipses indicate none reported.
†One 16-year-old boy reported 12 oz and one 17-year-old boy reported 23 oz of beer.
‡One 16-year-old girl reported 21 oz of beer, one 15-year-old girl and one 17-year-old girl each reported 1 oz of liquor.

ASSOCIATIONS BETWEEN BEVERAGE CONSUMPTION AND NUTRIENT INTAKE

The adjusted OR can be interpreted as the percentage of change in the likelihood of achieving recommended nutrient intake on the day of recall associated with a 1-oz increase in the consumption of a given beverage, controlling for the other beverage categories and for sex, age in years within the age stratum, race/ethnic group, PIR, and total energy intake for the day (**Table 4**). For example, each ounce of milk consumed by a 2- to 5-year-old increased the likelihood of achieving the recommended intake of vitamin A by 13% (OR=1.13) and each ounce of carbonated soda decreased the likelihood by 3% (OR=0.97). Coffee and tea, consumed primarily by 12- to 17-year-olds, was not significantly associated with the likelihood of achieving recommended intakes of the nutrients we considered and did not interact with any of the other beverages in the models; thus, we did not retain coffee and tea in the analysis. Sports drinks and alcoholic beverages were reported by few children in any age group and were not included in the analysis.

Milk consumption was positively associated with the likelihood of achieving recommended vitamin A, folate, vitamin B_{12}, calcium, and magnesium intakes on the day of recall in all age strata. Juice consumption was positively associated with the likelihood of achieving recommended vitamin C and folate intakes for all children and achieving magnesium intake among children aged 6 years and older, but was negatively associated with the likelihood of achieving recommended vitamin B_{12} intake among 12- to 17-year-olds. Fruit-flavored drink consumption was positively associated with achieving recommended vitamin C intake for all children. Carbonated soda consumption was negatively associated with the likelihood of achieving recommended vitamin A intake for all age strata, vitamin C among 2- to 5-year-olds, vitamin B_{12} for 6- to 11-year-olds, calcium for 2- to 5-year-olds and 6- to 11-year olds, and magnesium for 6- to 11-year-olds and 12- to 17-year-olds.

In all models, total daily energy intake was significantly positively associated with the likelihood of achieving the recommended intakes of all nutrients (P≤.001) but ethnic group and PIR were not (data not shown). The association with energy intake is not attributable to significant differences in the energy content of the beverages included in the model. We interpret the positive association between energy and nutrient intake to mean that children who eat and drink more food and beverages of whatever kind have the opportunity to consume more nutrients. Ethnic group was significantly associated with milk consumption (non-Hispanic black children drank less milk than other children, P≤.0001) and PIR was associated with juice consumption (a significant linear trend of higher juice consumption with higher PIR, P≤.001) (data not shown).

COMMENT

In multivariate analysis, the likelihood of achieving recommended intakes of most of the nutrients evaluated increased significantly with the consumption of milk and 100% juice, and decreased significantly with the consumption of carbonated sodas for children of all ages. The likelihood of achieving recommended vitamin C intake increased with the consumption of fruit-flavored drinks, consistent with a recent report that fruit-flavored drinks containing less than 100% juice provided 14% of the vitamin C intake for children in the United States.[5] This is attributable to the part-juice content or added vitamin C of many of the fruit-flavored drinks. In our analysis, drinks containing 100% juice contributed to folate and magnesium intakes but fruit-flavored drinks did not.

For a given nutrient, we compared the relative effects of milk, juice, fruit-flavored drinks, and carbonated sodas on the day of recall. For example, milk con-

sumption increased the likelihood of achieving recommended calcium intake between 25% and 37% per ounce, depending on the age stratum (OR, 1.25-1.37). Carbonated soda consumption decreased the likelihood by 3% to 5% per ounce (OR, 0.97-0.95). Although the effect associated with an ounce of beverage consumption may be small, it can be translated into the effect of a median serving. For 2- to 5-year-old girls, the median serving of 8 oz of carbonated soda would decrease the likelihood of achieving recommended calcium intake by 40%. Substituting 8 oz of milk for the soda would increase the likelihood by 296%, that is, almost 3 times.

Because the ORs were calculated separately for each nutrient and each age stratum, we cannot compare the magnitude of the effect of a given beverage across nutrients. We cannot assert, for example, that the 2% per ounce decrease in likelihood of achieving recommended vita-

Table 3. Spearman Rank-Order Correlations Among Beverages Consumed by Children Aged 2 to 17 Years

Age Group, y	Carbonated Soft Drinks		Fruit-Flavored Drinks		Milk and 100% Juice
	Milk	100% Juice	Milk	100% Juice	
2-5					
Boys (n = 893)	-0.17*	-0.37*	-0.11‡	-0.28*	-0.03
Girls (n = 907)	-0.18*	-0.26*	-0.09‡	-0.20*	-0.07
6-11					
Boys (n = 643)	-0.30*	-0.26†	-0.13†	-0.11‡	0.05
Girls (n = 639)	-0.28*	-0.20†	-0.12†	-0.08‡	-0.02
12-17					
Boys (n = 511)	-0.20*	-0.15†	-0.05	-0.09	0.05
Girls (n = 477)	-0.24*	-0.13†	-0.04	-0.08	-0.03

*P≤.0001.
†P≤.001.
‡P≤.01.

Table 4. Adjusted Odds Ratios of Achieving Recommended Intakes of Selected Nutrients Among Children Aged 2 to 17 Years*

Age Group, y	Odds Ratio (99% Confidence Limit)					
	Vitamin A	Vitamin C	Folate	Vitamin B₁₂	Calcium	Magnesium
2-5						
Milk	1.13 (1.0, 1.16)†	1.01 (0.99, 1.03)	1.05 (1.03, 1.08)†	1.47 (1.37, 1.58)†	1.37 (1.31, 1.45)†	1.24 (1.13, 1.35)†
100% Juice	1.01 (0.94, 1.00)	1.22 (1.12, 1.33)†	1.07 (1.03, 1.11)†	0.96 (0.90, 1.03)	1.00 (0.96, 1.03)	1.08 (0.96, 1.21)
Fruit-flavored drink	1.01 (0.98, 1.04)	1.24 (1.18, 1.30)†	1.01 (0.97, 1.05)	1.01 (0.95, 1.08)	1.03 (0.97, 1.08)	1.05 (0.94, 1.17)
Carbonated soda	0.97 (0.94, 0.99)‡	0.97 (0.95, 0.99)‡	0.99 (0.96, 1.02)	0.99 (0.89, 1.10)	0.96 (0.91, 0.99)§	0.90 (0.79, 1.04)
6-11						
Milk	1.10 (1.07, 1.13)†	1.03 (0.99, 1.06)	1.05 (1.02, 1.09)†	1.23 (1.13, 1.34)†	1.35 (1.21, 1.30)†	1.14 (1.09, 1.20)†
100% Juice	1.01 (0.97, 1.04)	1.47 (1.32, 1.64)†	1.08 (1.03, 1.12)†	0.99 (0.91, 1.08)	0.96 (0.93, 1.00)	1.08 (1.01, 1.15)§
Fruit-flavored drink	1.01 (0.98, 1.04)	1.27 (1.19, 1.35)†	1.01 (0.99, 1.03)	1.00 (0.95, 1.05)	1.01 (0.98, 1.04)	1.02 (0.99, 1.06)
Carbonated soda	0.98 (0.94, 0.99)‡	0.97 (0.94, 1.01)	0.98 (0.96, 1.00)	0.96 (0.92, 0.99)‡	0.97 (0.94, 0.99)‡	0.95 (0.92, 0.99)§
12-17						
Milk	1.07 (1.04, 1.10)†	1.03 (1.01, 1.06)‡	1.05 (1.02, 1.07)†	1.19 (1.13, 1.25)†	1.25 (1.21, 1.30)†	1.09 (1.06, 1.12)†
100% Juice	1.01 (0.98, 1.05)	1.34 (1.19, 1.50)†	1.07 (1.03, 1.10)†	0.96 (0.93, 0.99)‡	1.02 (0.97, 1.07)	1.05 (1.01, 1.09)§
Fruit-flavored drink	1.01 (0.98, 1.04)	1.17 (1.11, 1.24)†	1.00 (0.98, 1.03)	1.01 (0.98, 1.03)	1.00 (0.96, 1.04)	0.99 (0.96, 1.02)
Carbonated soda	0.98 (0.97, 0.99)‡	0.99 (0.97, 1.00)	0.98 (0.97, 1.00)	0.98 (0.96, 1.00)	0.99 (0.96, 1.00)	0.98 (0.97, 0.99)†

*Adjusted for sex, age in years within age stratum, ethnic group (non-Hispanic white, non-Hispanic black, Mexican American), poverty-income ratio, and total energy intake. Percent change in the likelihood of achieving recommended intake associated with a 1-oz increase in beverage consumption. Odds ratios greater than 1.00 indicate an increase in the likelihood; odds ratios less than 1.00, a decrease in the likelihood.
†P≤.0001.
‡P≤.01.
§P≤.001.

min A intake associated with carbonated soda is equivalent to the 2% per ounce decrease for folate. Similarly, we cannot directly compare the magnitude of the effects across age strata. However, we can note that some patterns of association are consistent across nutrients and across age strata. Milk and 100% juice consumption were positively associated with the intake of most nutrients in most age strata. In contrast, the association between carbonated soda consumption and nutrient intakes was less consistently significantly associated with nutrient intake across the age strata. It is also notable that the positive associations for milk and juice are of larger magnitude than the negative associations for carbonated sodas in any given model. We might cautiously interpret this to mean that when controlling for carbonated soda intake the positive effect of milk or juice is substantial, but when controlling for milk and juice intake, the negative effect of sodas is modest.

Hamrack et al[4] assessed the effects of nondiet carbonated soda consumption in the 1994 CSFII data. They compared mean nutrient intakes across 3 categories of soda consumption (0, 1.0-8.9, and ≥9.0 oz). They found that children in the highest soda consumption category consumed less milk and juice and had lower vitamin A, vitamin C, folate, and calcium intakes than children in the lowest soda category. Our analysis is consistent with theirs but our analysis also quantifies the association between carbonated soda consumption and nutrient intake across the full range of consumption. In addition, our analysis considers the simultaneous effects of milk, 100% juice, fruit-flavored drinks, and carbonated sodas.

Although Hamrack et al[4] asserted that carbonated sodas displaced milk and juice, our results indicate only a modest inverse relationship that accounted for less than 10% of the variance in milk consumption and less than 15% of the variance in juice consumption. The correlations between fruit-flavored drinks and milk or juice were of even lower magnitude. More important than the magnitude of the negative association, however, is the fact that we could not infer that carbonated sodas displaced milk or juice because we did not know whether children had consumed more milk or juice in the absence of carbonated sodas. Most children drank 2 or 3 kinds of beverages on the day of recall. The question of displacement of 1 beverage by another cannot be addressed in a cross-sectional data set such as the CSFII.

We were concerned with the possibility of underreporting intakes, especially beverages that may have been consumed apart from meals and thus more likely to be inadvertently forgotten.[15] It is also possible that children or their parents might have underreported beverages perceived as inappropriate, such as carbonated sodas, coffee and tea, or alcoholic beverages.[15] However, it is unlikely that such underreporting would vary systematically with nutrient intake so we believe that our results are unbiased.

We do not have data derived from vitamin and mineral supplements. The data set only indicated whether children took supplements regularly, occasionally, or not at all. The frequency of supplement use did not vary across quartiles of beverage consumption.

Given the limitations of these data, we cannot assert that carbonated sodas or fruit-flavored drinks displaced milk or 100% juice in our sample. Our analysis does demonstrate, however, a strong association between the amount of milk or 100% juice consumed on a given day and the likelihood of achieving recommended intakes of the nutrients we examined. We also demonstrated a modest inverse association between nutrient intakes and carbonated soda consumption. It is therefore prudent to recommend that children be encouraged to drink milk and 100% juice rather than less nutrient-dense beverages. A decrease of 1 glass of carbonated soda coupled with an increase of 1 glass of milk or juice could have a substantial effect on a child's daily nutrient intake.

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Correction

Error in Reported Figures and in Reference Name. In the nutrition article titled "Beverage Choices Affect Adequacy of Children's Nutrient Intakes," published in the November issue of the ARCHIVES (2000;154:1148-1152), on page 1151, the fifth line in column 2 should have read "by 1% to 4% per ounce (OR, 0.99-0.96)" and the sentence starting on the eighth line should have read: "For 2- to 5-year-old girls, the median serving of 8 oz of carbonated soda would decrease the likelihood of achieving recommended calcium intake by 28%. Substituting 8 oz of milk for the soda would increase the likelihood by 1141%, that is, more than 10 times." On page 1152, in paragraphs 2 and 3 and reference 4, the first author should have been Harnack.